

Laser remediation of threats posed by small orbital debris

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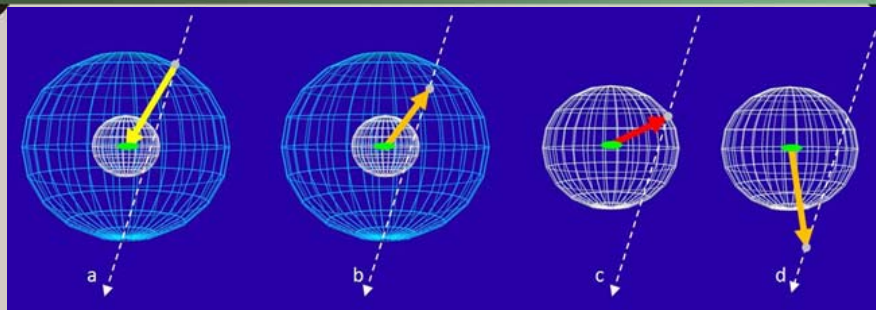
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The continually increasing amount of orbital debris in near Earth space poses an increasing challenge to space situational awareness. Recent collisions of spacecraft caused abrupt increases in the density of both large and small debris in near Earth space. An especially challenging class of threats is that due to the increasing density of small (1 mm to 10 cm dimension) orbital debris. This small debris poses a serious threat since: (1) The high velocity enables even millimeter dimension debris to cause serious damage to vulnerable areas of space assets, e.g., detector windows; (2) The small size and large number of debris elements prevent adequate detection and cataloguing. We have identified solutions to this threat in the form of novel laser systems and novel ways of using these laser systems. While implementation of the solutions we identify is challenging we find approaches offering threat mitigation within time frames and at costs of practical interest. We base our analysis on the unique combination of coherent light specifically structured in both space and time and applied in novel ways entirely within the vacuum of space to deorbiting small debris. We compare and contrast laser based small debris removal strategies using ground based laser systems with strategies using space based laser systems. We find laser systems located and used entirely within space offer essential and decisive advantages over ground-based laser systems.



Laser Remediation of Threats Posed by Small Orbital Debris

University of Alabama, Huntsville and MSFC
Description: Space-based laser remediation of small orbital debris



DEORBITING EVENT: a. Small orbital debris detected using scattered sunlight, b. Tracking laser acquires debris, c. Modelocked laser exerts impulse, d. Outcome validated.

PROBLEM: Small orbital debris elements (1-10 cm) increasingly threaten resources in space. These debris elements are numerous, difficult to detect and variable in location with time.

SOLUTION: A unique spacecraft and laser system designed to detect approaching small orbital debris using scattered sunlight, establish laser tracking of the debris element at distances up to 50 km, exert a deorbiting impulse at 10 km, and then verify the outcome of the deorbiting effort by measuring the reduced velocity of the departing debris.

UAH CAPABILITIES: (1) Designing modelocked laser systems capable of exerting required deorbiting impulse; (2) Testing large optics in vacuum.

DISCRIMINATORS: Extensive experience in designing, building, testing, and developing novel world class modelocked laser systems and in testing, e.g. James Webb telescope elements in the XRCF at MSFC facility.

INNOVATIVE FEATURE: Novel modelocked laser system for deorbiting small debris using low power, 10 kW, brief illumination time, 1 sec, and short range, 10 km.

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- Dr. Jan Rogers is the MSFC POC for laser ablation and the use of the MSFC electrostatic levitation system which can be used to provide a high-vacuum environment to study the response of floating simulated debris elements to remediation techniques. E-mail: JAN.R.ROGERS@NASA.GOV

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